Micrometrical and Visual Observations of Nova Cygni (1876) *made with the 40-inch Refractor of the Yerkes Observatory.*

By E. E. Barnard.

On the evening of 1876 November 24, at $5^h\ 45^m$, Schmidt at Athens discovered a brilliant star of the 3rd magnitude in *Cygnus* where a few days previous none such had existed. It rapidly faded, and by December 15 had ceased to be visible to the naked eye. The period of visibility without the telescope, therefore, did not extend over more than twenty-two days.

The most rapid decline in its light occurred between 1876 November 27 and November 29, when, according to Schmidt, in less than two days it faded through nearly $1\frac{1}{2}$ magnitude. From then on until it ceased to be visible to the naked eye the decline was slow and gradual at about 0·13 magnitude a day. By 1877 February 1 it had reached 7·5 magnitude. By 1877 September 1 it had declined to the 10th magnitude, at which brightness it remained for nearly a year. Throughout 1880 and the first part of 1881 it remained constant at slightly less than 12 magnitude. On 1882 March 24 the Dun Echt observers estimated it to be of the 14th magnitude. There seem to be no other observations to verify this last estimation. Nearly ten years later (July 31, 1891) Professor Burnham examined the star with the 36-inch of the Lick Observatory and estimated it to be 13·5 magnitude. He found it a little brighter than the star No. 50, which he estimated to be 14 magnitude. I have not found any later observations of the star.

At the observations in 1891 (*Pub. L. O.*, vol. ii., p. 179), Professor Burnham says: "At times the new star did not seem to have a perfectly stellar appearance under moderately high powers, but rather to resemble an exceedingly minute nebula. This appearance, however, may not be real. The star is too faint to allow one to decide a question of this kind with any certainty. I did not make any measures from surrounding stars, as that has been very thoroughly done by the authors of the paper referred to [Copeland and Lohse: *Copernicus*, vol. ii., 101]."

Fearing the possible total disappearance of the *Nova*, Copeland and Lohse made an extensive series of measures of its position with respect to 112 surrounding stars. These observers state in *Copernicus*, vol. ii.: "Towards the end of 1877 October *Nova Cygni* had decreased still further in brightness, and so pointed to the possibility that it might eventually fade altogether from view. In the event of such a contingency it seemed very desirable to possess a map of the small stars in the immediate neighbourhood; accordingly measures in position-angle and distance from the new star to surrounding objects were commenced on October 29 and added to as occasion offered, until the whole series of measures extended to 38 nights, the last being 1882

March 24. The resulting map includes every star fairly measurable with the Dun Echt refractor of 15·06 inches aperture within $7\frac{1}{2}'$ of *Nova Cygni*. . . . In this place it may be well to particularise a very small star, probably about the 15th magnitude, at a distance of 19″·1, in position-angle 314°·2 from *Nova*, as in a superficial examination it might possibly be confounded with the new star in the event of the total disappearance of the latter."

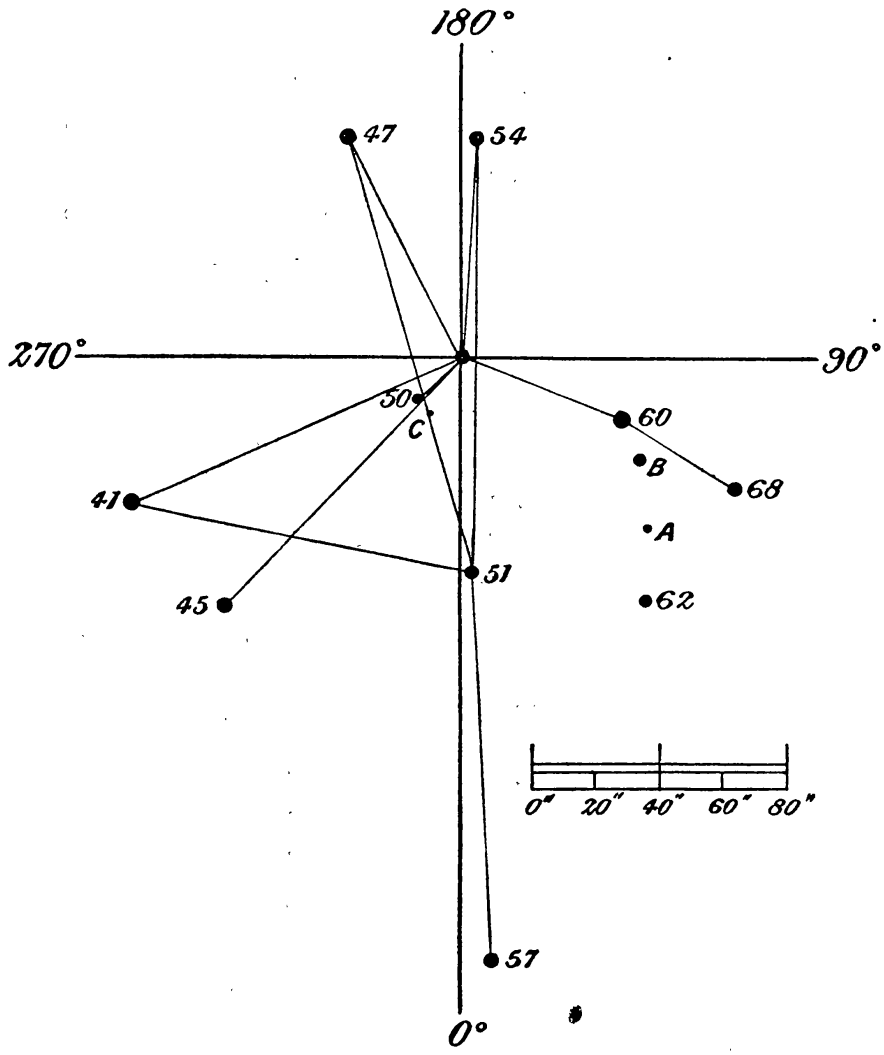
These measures and a most excellent map of 113 stars (including the *Nova*) are printed in *Copernicus*, Nos. 18 and 19, for 1882 June and July, for a copy of which I am greatly indebted to Dr. Ralph Copeland, Astronomer Royal for Scotland. The positions of these stars are reduced to the epoch 1878·0. I am also indebted to Dr. See for copies of the chart and of some of the measures in *Copernicus* from the library of the U.S. Naval Observatory.

To see if any change has occurred in the place of the new star in the past quarter of a century, I have selected a few of these stars for re-measurement along with the *Nova*. The re-measurement of all the stars observed at Dun Echt would be an unnecessary piece of labour, I therefore selected those stars near the *Nova* and which were within about two minutes of arc from it.

When I first looked up this object, on 1901 October 21, I adopted Schmidt's position of it given in *Ast. Nach.*, Bd. 89, p. 10, not having any chart by which to identify its place. Unfortunately Schmidt's position was in error (corrected later on in *A. N.*). Singularly enough the erroneous place coincided to within one second of time and a few seconds of arc, with a 15^m star (No. 51) which I observed that night and the next for the *Nova*. Upon deducing the place of this star from the observed $\Delta\alpha$ and $\Delta\delta$ and comparing it with the meridian positions obtained at Berlin (*A. N.* 2113, Bd. 89, p. 14), it was seen that the wrong star had been observed. This accounts for the measures of No. 51 on October 21 and 22. For the sake of accuracy I have since added one more night's measures to these stars. After this the *Nova* was easily identified.

I have charted the stars measured here with the 40-inch, and as a ready means of identifying the various measures at a glance I have not only added the numbers of the stars, but have also indicated the measures by lines connecting the various stars. Thus at a glance, without having resort to the actual measures, one can identify any star without trouble. It is to be regretted that diagrams of this kind are so often printed without any means of identifying any individual star without recourse to the measures and a protractor. Often I have been confused and uncertain in picking out the stars on such diagrams, without having a protractor immediately at hand to indicate the angles. In the chart in *Copernicus* of *Nova Cygni* this is not so bad, because the coordinates are printed on the map. But even here the identification of the individual stars would be much facilitated by numbering them on the chart. With such charts as I mention

it is an easy matter to identify the corresponding stars in the sky. But you still do not know the number of this or that particular star in the list of measures. If it happens to be at the telescope that a particular star on the chart is wanted to be identified by its number, as is frequently the case, it becomes very annoying and is the source of the loss of much time. I have, therefore, gone to the trouble of identifying the stars on such charts by scale and protractor, and numbering them to save time and confusion.



On the present chart the numbers are those assigned the stars at Dun Echt.

I have inserted four additional stars besides those measured. The star A is very faint = 16½ magnitude. B is of the same brightness as 62, while C, the very faint star mentioned near 50,

is extremely difficult under not very fair conditions. The star 62 has been inserted because of the comparisons of the light of the *Nova* with it.

Following are the measures :—

Micrometer Measures of Stars near Nova Cygni (1876).

Nova and No. 60. Magnitude 11·4.

1901·844	Nov. 4	70°·15	52″·53
·846	5	70·48	53·10
·866	12	70·51	52·66*
·926	Dec. 4	70·58	52·47†
·961	17	70·25	53·06
·997	30	70·05	52·96
1901·907		70·34	52·80

These give $\Delta\alpha = 0^m\ 4^s\cdot488$, $\Delta\delta\ 0'\ 17''\cdot77$.

* Single distances ; clouds.
† Two single distances ; clouds.

Nova and No. 54. Magnitude 12·1.

1901·844	Nov. 4	175°·27	67″·83
·846	5	175·94	68·08
·926	Dec. 4	175·88	67·82
1901·872		175·70	67·91

Nova and No. 47. Magnitude 12·2.

1901·844	Nov. 4	206°·27	76″·67
·846	5	206·04	76·49
·826	Dec. 4	206·27	76·39
1901·839		206·19	76·52

Nova and No. 41. Magnitude 13·2.

1901·846	Nov. 5	294°·01	110″·09
·866	12	294·46	...*
·926	Dec. 4	294·01	110·02
·994	29	294·13	110·05
1901·908		294·15	110·05

* Clouds prevented distance measures.

Nova and No. 50. Magnitude 16·0.

1901·926	Dec. 4	312°·97	19″·38*
·961	17	315·54	20·09
·997	30	316·05	19·87
1901·961		314·86	19·78

* There is a $16^{m}\cdot8$ star close north of 50.

Nova and No. 45. Magnitude 13·7.

1901·961	Dec. 17	316°·28	106″·17
·994	29	316·28	106·05
1902·005	Jan. 2	316·21	105·80
1901·987		316·26	106·01

Nova and No. 51. Magnitude 15·3.

1901·844	Nov. 4	2°·48	66″·60
·846	5	2·34	66·68
·882	18	2·32	66·64
·926	Dec. 4	2·11	66·71
1901·875		2·31	66·66

These give $\Delta\alpha = 0^{m}\ 0^{s}\cdot243$, $\Delta\delta = 1'\ 6''\cdot61$.

Positions of Stars with reference to No. 51.

No. 51 and No. 57. Magnitude of No. 57, 12·0.

1901·808	Oct. 22	2°·62	116″·83
1902·033	Jan. 12	2·57	117·07
·035	13	2·55	117·21
1901·959		2·58	117·04

No. 51 and No. 60.

1901·808	Oct. 22	135°·52	67″·98
1902·033	Jan. 12	135·35	68·19
1901·920		135·43	68·08

These give $\Delta\alpha = 0^{m}\ 4^{s}\cdot378$, $\Delta\delta = 0'\ 47''\cdot78$.

No. 51 and No. 54.

1901·808	Oct. 22	178°·92	133″·86
1902·033	Jan. 12	178·84	134·24
1901·920		178·88	134·05

No. 51 and No. 47.

1901·808	Oct. 22	195°·08	140″·18
1902·033	Jan. 12	194·64	140·17
1901·920		194·86	140·18

No. 51 and No. 41.

1901·808	Oct. 22	258°·20	105″·21
1902·033	Jan. 12	257·90	105·21
1901·920		258·05	105·21

No. 60 and No. 68. Magnitude of No. 68 = 13·5.

1902·071	Jan. 26	57°·62	31″·84
·074	27	57·77	31·73
1902·073		57·69	31·78

In general the magnifying power used was 460, but some of the measures were made with 700 diameters.

Following are comparisons of these measures with those made at Dun Echt in 1877–82 :—

Nova and No. 41.

Dun Echt	293°·4	... ...	108″·6
Yerkes	294·1	... ...	110·1
D. E. – Y.	= −0·7	... ...	−1·5

Nova and No. 45.

Dun Echt	315°·0	... ...	107″·9
Yerkes	316·3	... ...	106·0
D. E. – Y.	−1·3	... ...	+1·9

Nova and No. 47.

Dun Echt	206°·2	... ...	78″·2
Yerkes	206·2	... ...	76·5
D. E. – Y.	0·0	... ...	+1·7

Nova and No. 50.

Dun Echt	314°·2	... ...	19″·1
Yerkes	314·9	... ...	19·8
D. E. – Y.	−0·7	... ...	−0·7

Nova and No. 51.

Dun Echt	358°.5	63″.7
Yerkes	362.3	66.7
D. E.−Y.	−3.8	−3.0

Nova and No. 60.

Dun Echt	69°.7	55″.2
Yerkes	70.3	52.8
D. E.−Y.	−0.6	+2.4

No correction has been applied to the angles for precession.

These discrepancies are rather large. They do not seem to be due to any systematic errors nor to motion in the *Nova*. It is scarcely probable that they are due to motion in any of these small stars themselves.

The Dun Echt observers state, in *Copernicus* Nos. 18–19, p. 117, that "the probable error of one of the places is about ±1″.1 in either coordinate; this quantity is disappointingly large, but is probably to be ascribed in some measure to two special causes—the peculiar light of the *Nova*, which threw its image out of focus, and the fact that the settings could not all be made in the centre of the apparent field of view." The magnifying power used at Dun Echt was nearly always 229.

The star No. 60 is the one mentioned by Schmidt as a companion to the *Nova*, of the 12–13^m, 4^s.25 fol. and 15″.5 north. Schmidt's position was determined from two transits of a ring micrometer, and are not very exact (*A. N.* 2122, Bd. 89, p. 159).

Following are the observations for the position of the *Nova*, made with respect to the stars Bonn A. G. Cat. 15868 (D.M. +42°.4184) and 15876 (D.M. +42°.4185) :—

Observed $\Delta\alpha$ *and Measured* $\Delta\delta$.

No. 51 and D.M. +42°.4184.

			m s		′ ″
1901.805	Oct. 21	$\Delta\alpha$	0 24.51 (10)	$\Delta\delta$	2 20.41 (2)
.808	22		0 24.50 (14)		2 20.92 (3)
1901.806			24.50 (28)		2 20.71 (5)

No. 51 is north preceding.

No. 51 and D.M. +42°.4185.

			m s		′ ″
1901.805	Oct. 21	$\Delta\alpha$	0 34.96 (10)	$\Delta\delta$	0 9.10 (2)
.808	22		0 34.90 (14)		0 9.67 (4)
1901.806			0 34.92 (28)		0 9.48 (6)

No. 51 is south preceding.

No. 60 and D.M. +42°·4185.

			m s	′ ″
1901·808	Oct. 22	Δα	...	Δδ 0 57·96 (2)
·827	29		0 30·65 (8)	0 58·01 (1)
1901·817			0 30·65 (8)	0 57·98 (3)

No. 60 is south preceding.

No. 60 and D.M. +42°·4184.

1901·827	Oct. 29	Δα	$0^m\ 20^s{\cdot}25$ (8)	Δδ 1′ 32″·04 (2)

No. 60 is north preceding.

No. 51 and No. 60.

1901·805	Oct. 21	Δα	0′ 47″·50 (2)	Δδ 0′ 48″·42 (2)

$\frac{1}{15}$ sec δ (= 4ˢ·29).

No. 51 is north preceding No. 60.

Nova and No. 60.

1901·827	Δα	0′ 51″·00 (4)	Δδ 0′ 17″·78 (5)

$\frac{1}{15}$ sec δ (= 4ˢ·60) reject.

Nova is south preceding No. 60.

At the observations for Δα *Nova* was very difficult, and the measures should be rejected.

All the measures have been corrected for refraction.

As the comparisons with the Dun Echt measures do not seem to indicate with any certainty any motion in the *Nova*, it has occurred to me that this question might be settled by the comparisons of some of the stars and the *Nova* with the two D.M. stars following the new star, which have been observed on the meridian, and with the meridian observations of the *Nova* itself made some twenty-five years ago.

This investigation follows.

The star D.M. +42°·4184 has been observed at Bonn, Dun Echt, and Greenwich. These positions brought up to 1901·0 are in fair accord—

D.M. +42°·4184.

		h m s	° ′ ″	
1901·0	α	21 38 14·24	δ = +42 22 10·54	Bonn Beob.
		21 38 14·41	42 22 11·08	Bonn A.G. Cat.
		21 38 14·41	42 22 10·48	Greenwich and Dun Echt.
1901·0		α = 21 38 14·38	δ = +42 22 10·65	

Equal weight is given in these to the different observatories.

The star D.M. +42°·4185 has been observed at Bonn.

1901·0 $21^h\ 38^m\ 24^s\cdot60$ $+42°\ 24'\ 39''\cdot5$ Bonn A.G. Cat

From the first of these stars (42°·4184) we get the following position for star 51 from the observed $\Delta\alpha$ and $\Delta\delta$.

Star 51 1901·0 $\alpha = 21^h\ 37^m\ 49^s\cdot88$ $\delta = +42°\ 24'\ 31''\cdot36$ (A)

And this, with the observed position-angle and distance, gives the following position :

Nova 1901·0 $\alpha = 21^h\ 37^m\ 49^s\cdot67$ $\delta = +42°\ 23'\ 24''\cdot70$ (1)

From the same star (42°·4184) the following position of No. 60 is obtained from the observed differences of α and δ :

Star 60 1901·0 $\alpha = 21^h\ 37^m\ 54^s\cdot13$ $\delta = +42°\ 23'\ 42''\cdot69$ (*a*)

From the position-angle and distance this gives for the

Nova 1901·0 $\alpha = 21^h\ 37^m\ 49^s\cdot64$ $\delta = +42°\ 23'\ 24''\cdot92$ (2)

From the second star (42°·4185) we similarly deduce the following position of

No. 51 1901·0 $\alpha = 21^h\ 37^m\ 49^s\cdot67$ $\delta = +42°\ 24'\ 30''\cdot12$ (B)

From which the position of the *Nova* is derived as before.

Nova 1901·0 $\alpha = 21^h\ 37^m\ 49^s\cdot43$ $\delta = +42°\ 23'\ 23''\cdot51$ (3)

This star (42°·4185) also gives the place of

No. 60 1901·0 $\alpha = 21^h\ 37^m\ 53^s\cdot95$ $\delta = +42°\ 23'\ 41''\cdot52$ (*b*)

And this in turn gives for the *Nova* :

Nova 1901·0 $\alpha = 21^h\ 37^m\ 49^s\cdot46$ $\delta = +42°\ 23'\ 23''\cdot75$ (4)

Collecting these four positions of the *Nova* for 1901·0 we have

	h m s	° ′ ″
(1)	$\alpha = 21\ 37\ 49\cdot67$	$\delta = +42\ 23\ 24\cdot70$
(2)	21 37 49·64	42 23 24·92
(3)	21 37 49·43	42 23 23·51
(4)	21 37 49·46	42 23 23·75
1901·0	$\alpha = 21\ 37\ 49\cdot55$	$\delta = +42\ 23\ 24\cdot22$

The two first positions, depending on star 42°·4184, and the two last, on star 42°·4185, show a systematic difference amounting to $0^s\cdot2$ and $1''$ in α and δ respectively. This is perhaps due to motion in one or the other of the two stars.

Collecting the various meridian observations of the *Nova*, made when it was in its brighter stages, I find there were four observations. Bringing these up to 1901·0 we have

Positions of the Nova from Meridian Observations.

	h m s	° ′ ″	W.	
1901·0	α = 21 37 49·41	δ = +42 23 24·20	(2)	Vienna.
	21 37 49·47	42 23 23·98	(4)	Berlin.
	21 37 49·55	42 23 23·33	(5)	Greenwich.
	21 37 49·40	42 23 25·33	(1)	Dun Echt.
1901·0	α = 21 37 49·49	δ = +42 23 23·86		

The weights assigned there are from the number of observations. One of the observations at Vienna was given half weight, as it was observed under poor conditions.

Comparison of the mean of these positions with that of mine shows no certain change in the place of the *Nova*.

The agreement would be closer if we used the observations referred to 42°·4185 alone. As this last star place rests on nine observations it would seem that there has been a small change in the place of 42°·4184 and no change in that of the *Nova*.

The magnitudes I have assigned to the stars are the mean in each case of several estimates.

Following are comparisons of the magnitudes :—

Star 41.	m
Dun Echt	13·4
Yerkes	13·2
D. E.−Y.	+0·2

Star 49.	m
Dun Echt	14·7
Yerkes	14·0
D. E.−Y.	+0·7

Star 42.	
Dun Echt	15·0
Yerkes	14·0
D. E.−Y.	+1·0

Star 50.	
Dun Echt	15·0
Yerkes	16·0
D. E.−Y.	−1·0

Star 45.	
Dun Echt	14·4
Yerkes	13·7
D. E.−Y.	+0·7

Star 51.	
Dun Echt	14·3
Yerkes	15·3
D. E.−Y.	−1 0

Star 4	
Dun Echt	11·9
Yerkes	12·2
D. E.−Y.	−0·3

Star 54.	
Dun Echt	12·0
Yerkes	12·1
D. E.−Y.	−0·1

Star 57.		Star 68.	
Dun Echt	13·4	Dun Echt	14·0
Yerkes	12·0	Yerkes	13·2
D. E.−Y.	+1·4	D. E.−Y.	+0·8

Star 60.		Star 73.	
Dun Echt	11·0	Dun Echt	13·4
Yerkes	11·4	Yerkes	12·5
D. E.−Y.	−0·4	D. E.−Y.	+0·9

Collecting these differences of magnitude, we have :—

m	m
+0·2	−0·1
+1·0	+1·4
+0·7	−0·4
−0·3	+0·8
+0·7	+0·9
−1·0	D. E.- Y. = +0·2
−1·0	

The magnitudes of those stars which were not micrometrically measured by me should not have much weight, as they would not be so carefully estimated.

These discordances of magnitude are not very large, and no more than would be expected from different observers with different telescopes and such faint objects as some of these stars are.

It must be understood, however, that these estimates have been made under the most unfavourable conditions of seeing here, when a star anyways near the limit of the 40-inch would not be seen.

On several occasions I have seen a very faint star near No. 50 and north of it. It was too faint to measure—and there was no reason for measuring it.

By estimation, in terms of other distances and position-angles, this small star would be, with reference to No. 50, in

P. 20°± Dist. 5″±.

No. 50 is a faint star to have been measured at Dun Echt. There does not seem to have been any change in its brightness, though one would almost infer that it must have been brighter some twenty or twenty-five years ago.

It is difficult to estimate the brightness of the *Nova*. It seems to be more affected by bad seeing or moonlight than the small stars near it. This is another indication of its probable nebulous

character. My estimates of its relative light seemed to show that it varied through about $\frac{1}{2}$ magnitude. This, I think, however, is due to its lack of exact definition and the effect of local conditions of moonlight or bad seeing, though I am not sure yet that there is not a fluctuation of its light.

Following are estimations of the brightness of the *Nova* with respect to the stars 50 and 51.

Comparisons of the Brightness of the Nova.

1901 Nov.	12	*Nova*	=	51 and possibly slightly brighter.				
	18	,,	=	51.				
	19	,,	=	$\frac{5}{10}^m$	less than	51.		
Dec.	4	,,	=	$\frac{2}{10}^m$	,,	,,	$\frac{2}{10}^m$	brighter than 50.
	17	,,	=	$\frac{3}{10}^m$	,,	,,	$\frac{5}{10}^m$	,, ,,
	22	,,	=	$\frac{5}{10}^m$	,,	,,	$\frac{1}{10}^m$	,, ,,
	29	,,	=	51	...	...	$\frac{5}{10}^m$	,, ,,

The following estimates are more carefully made and are believed to be more exact. They were made specially to decide the question of variability.

1901 Dec.	30	*Nova*	$\frac{1}{10}^m$	less than	51	...	$\frac{4}{10}^m$	brighter than 50.
1902 Jan.	2		midway between 50 and 51.					
	5		$\frac{3}{10}^m$	less than	51	...	$\frac{1}{10}^m$	,, ,,
	6		$\frac{3}{10}^m$	,,	,,	...	$\frac{5}{10}^m$	,, ,,
	7		$\frac{2}{10}^m$	,,	,,	...	$\frac{5}{10}^m$	,, ,,
	10		$\frac{2}{10}^m$	,,	,,	...	$\frac{4}{10}^m$	,, ,,
	11		$\frac{3}{10}^m$	,,	,,	..	$\frac{3}{10}^m$	,, ,,
	12		$\frac{3}{10}^m$	,,	,,	...	$\frac{3}{10}^m$	,, ,,
	13		$\frac{3}{10}^m$	,,	,,	...	$\frac{2}{10}^m$	,, ,,
	14		$\frac{2}{10}^m$	,,	,,	...	$\frac{4}{10}^m$	,, ,,
	18		$\frac{2}{10}^m$	,,	,,	...	$\frac{4}{10}^m$	,, ,,
	26		$\frac{2}{10}^m$	,,	,,	...	$\frac{4}{10}^m$	,, ,,
	27		$\frac{4}{10}^m$	,,	,,	...	$\frac{2}{10}^m$	,, ,,
Means			0·25				0·34	

These estimates do not seem to be decisive. It is rather probable though that, on account of the physical appearance of the *Nova*, these differences do not indicate variability. They may prove valuable, however, in the future in deciding any question of change.

With these, and the estimated magnitudes of stars 50 and 51,

the following two determinations of the present brightness of *Nova Cygni* result from star 50, $15^{m}\cdot7$, and from star 51, $15^{m}\cdot6$.

From ten nights' comparisons the star No. 62 was found to be equal to No. 50 (the mean gave $0^{m}\cdot03$ less than No. 50), while from eleven nights' estimates, No. 62 was found to be $0^{m}\cdot35$ less than the *Nova*.

Twelve nights' comparisons made No. 51 less than No. 68 by $0^{m}\cdot18$.

In all the estimates of brightness the eyes were placed parallel to the line joining the stars. This is very important in my case, for, as I have shown in *A. J.* 370, vol. xvi. p. 75, two stars that are equal when the line between them is parallel to my eyes, will differ by half a magnitude when they are in a vertical line; the lower one being always the brighter. Just what is the cause of this peculiarity is not clear, but it seems that it might be due to a dulling of a portion of the retina by the preponderance of the illumination of the sky in the daytime over that of the landscape, about one half of the retina usually receiving the light from the sky, while the other half receives that from the landscape. The lower star would therefore fall on that part of the retina usually occupied by the landscape, and hence on a more sensitive portion.

Mr. J. A. Parkhurst has kindly measured the relative light of Nos. 50 and 51 with the photometer on the 40-inch. The difference as determined by him is $0^{m}\cdot66$ from one night's observations under rather unfavourable conditions. This is a little larger than the difference that would be derived from my estimates with the *Nova* and these two stars, and agrees almost exactly with the difference of my estimates of the magnitudes ($0^{m}\cdot7$) of the two stars themselves.

The changes of colour in this star were not very remarkable. At the time of discovery by Schmidt it was of a strong golden yellow. This colour, according to Schmidt, it retained until it ceased to be visible to the naked eye—to him it was at no time of a decided orange tint, but yet of a full yellow. When observable only with the telescope some of the observers described it as red.

According to Dr. Copeland, at Dun Echt, the star presented a rather complicated spectrum during its brighter stages in 1876 and the beginning of 1877. On 1876 December 5, when its magnitude was 4·5, he found that one of the spectral lines coincided almost exactly with the brightest line of the gaseous nebulæ. Another line corresponded very nearly with one of the bright lines in the spectra of the Wolf-Rayet stars in *Cygnus*. In the next eight or nine months the spectrum was reduced to a single line with the merest traces of a continuous spectrum. The star itself was later described as having "a small disc with a soft margin;" the *Nova* seemingly having become a nebula, both visually and spectroscopically. In reference to this remarkable change in the physical condition of the star, Dr. Copeland says, in *A. N.* 2158:—"Bearing in mind the history of this star from

the time of its discovery by Schmidt, it would seem certain that we have an instance before us in which a star has changed into a planetary nebula of small angular diameter. At least it may be safely affirmed that no astronomer discovering the object in its present state would, after viewing it through a prism, hesitate to pronounce as to its present nebulous character."

One striking feature about *Nova Cygni* mentioned by the Dun Echt observers was the fact that there was a decided difference in the focal adjustment for it and a star. According to Dr. Copeland, with the 15-inch Grubb refractor, this amounted on 1877 October 2, when the star was about 10^m, to about 2 mm. (the focus being outside of that for a star). In this respect it resembled *Nova Aurigæ* rather than *Nova Persei* of the past year. There seems to be no record of anything of this kind in its earlier stages of brightness in 1876, and it probably showed no such peculiarity then.

So far as I can learn, *Nova Aurigæ* in its first appearance, when bright, did not show this peculiarity, nor even when faint in the spring of 1892. It was only at its second apparition that the effect became evident. At present *Nova Persei* has shown nothing of this kind. In all probability, however, it will show it later on when it has become much less bright. It is the intention to frequently test the focus to see when this effect first becomes visible—if it makes its appearance at all. Careful tests up to 1902 January 31 showed no sensible difference between its focus and that of a star.

On account of the faintness of *Nova Cygni* it is difficult now to measure its focus with reference to a star in the ordinary way. Under the best seeing, however, there is certainly a slight difference of focus to the extent of possibly $\frac{1}{10}$-inch outside of that for a star. Even when in best focus it does not appear to be perfectly sharp. It seems to be more or less ill-defined, resembling in this the present appearance of *Nova Aurigæ*. Of course no colour is ever discernible in so faint an object.

I have examined *Nova Coronæ* (1866) several times lately, but always under very bad conditions of seeing. Under those conditions no difference of focus was noticeable between it and a star—though I hope to investigate this point more carefully later on with better seeing.

I have mentioned the want of *Nova Persei* to show any peculiarity in its focus from that of a fixed star. There is another peculiarity which I believe is important, but which in the greater interest due to the photographic nebulosity about the *Nova* is lost sight of. In the *Astrophysical Journal* for 1901 October, vol. xiv. No. 3, attention is called to the peculiar appearance of the *Nova* in the 40-inch: "On August 12, the seeing was unusually good; examining the *Nova* with high powers I was struck with its appearance. It was brighter than the star [D.M. $+43°\cdot732$], but under high magnifying powers its light was strikingly dull, having more the appearance of planetary

light. This was so decided, that had I been examining the stars in that region I should at once have singled out the *Nova* as different from any of the stars. The spurious disc appeared much duller and somewhat larger than that of a star, and of a slight yellowish colour."

As the new star has faded, this peculiarity has become even more striking. The light of the *Nova*, which is greenish white, is very much like that of *Neptune*, and when *Neptune* is seen with a power that just begins to show its disc, the general likeness to the *Nova* would be striking. The light, however, is more greenish than that of *Neptune*. It also strongly resembles *Ceres* when that planet is seen with not too high a power. The colour is also like some of the planetary nebulæ—especially N.G.C. 7662 in *Andromeda*. While the light from a star is vivid, that of *Nova Persei* is singularly dull with high powers.

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1902 *February* 5.

On the Variation of S Carinæ. By Alex. W. Roberts, D.Sc.

There are at present (February 1902) between 160 and 180 stars south of $-30°$ dec., whose variation is known with some degree of certainty.

Of this number ten are of marked interest, as their variation was discovered and definite minima and maxima determined by Dr. Gould. The star *S Carinæ* (Ch. 3637) is one of these Cordoba variables. Inasmuch as I have already dealt with the variation of *R Carinæ* (*Monthly Notices*, vol. lxi. p. 552) and with the variation of *R Centauri* (*Monthly Notices*, vol. lxi. p. 355), both stars whose variation was discovered and defined by Dr. Gould, it will, I think, give a measure of completeness to these papers to consider also the variation of *S Carinæ*.

It may be noted here that the three stars are good examples of three well-defined types of long-period variation.

We consider in the first place the data which are of service as leading to a determination of the period of the star.

Dr. Gould's note on the variation of *S Carinæ* is as follows (*Uranometria Argentina*, p. 253):—

"The fluctuations of the light of this star appear to be within the limits $6\frac{1}{4}^{m}$ and a little above 9^{m}, and the length of its period to be several months. In 1872 its magnitude was observed as follows: T., May 26,* 7·0; April 3, 6·9; H., May 24, 30, 8·0; R., July 28, 7·9; Aug. 7, 7·4. In 1874 it was twice observed by Mr. Thome, May 21, 6·3; June 9, 7·3; observations which place the variability of the star beyond question.

* March 26?